MEASUREMENT PROTOCOL

For Direct Solar Measurements
Using Sun Photometers

SIMBIOS Project, Code 970.2
NASA Goddard Space Flight Center
Greenbelt, MD 20770

Documentation for:
Microtops II (Solar Light Company, USA)
SIMBAD (Laboratoire d'Optique Atmosphérique, France)
SIMBADA (Laboratoire d'Optique Atmosphérique, France)
PREDE POM 01 Mark II (PREDE Company, Japan)

The purpose of this document is to provide all the information needed to capture high quality data with any SIMBIOS sun photometer. For further guidance, please write to: sunphoto@simbios.gsfc.nasa.gov.

Last edited: February 4, 2003

MICROTOPS II SUN PHOTOMETER

Contents

The Microtops II instrument should be shipped with the following items:

1. Microtops II case;
2. Microtops II instrument;
3. Microtops II serial cable;
4. Microtops II instruction manual;
5. Garmin GPS 38 unit;
6. GPS connector cable;
7. Garmin GPS case;
8. Garmin GPS instruction manual; and
9. Spare AA LR6 batteries (four each for Microtops II and Garmin GPS).

Figure 1 is a photo of the above parts

Figure 2: Close up of the Microtops II

Figure 3: Close up of the Garmin GPS 38

Setup

Hardware:

1. Check that the batteries for the Microtops II and Garmin GPS are loaded properly and functioning.
2. Clean the optics window of the Microtops II with non-abrasive paper or wipes. Use an alcohol (or other optics friendly) cleaning solution. Do not put the cleaning solution directly on the optics. Be sure to clean the Microtops II prior to use each day.

Figure 4: Materials needed for cleaning

GPS:

1. To turn on the Garmin GPS 38, push and hold the red button.
2. The unit will begin searching for satellites. When three satellites are found (indicated by three solid bars at the bottom of the LCD display), the unit will begin communicating with the Microtops II unit.
3. To reduce the amount of satellite search time, the geographical location can be entered into the unit prior to sue. To do this, press the [ENTER] button. A menu will appear on the LCD display. Select the first option "SELECT COUNTRY FROM LIST," by pressing the [ENTER] key again. A list of countries will appear. Use the arrow keys to select a country, then press [ENTER] again to confirm the choice.
4. Effective search time can also be reduced by turning the GPS unit on an hour or so prior to the first Microtops II deployment.
5. Subsequent operation during field deployment should require much less search time.

For more information, please refer to: "Owner's Manual & Reference: Garmin GPS 38."

MICROTOPS II:

1. Turn on the Microtops II by pressing the ON/OFF button. The instrument will beep, and begin making dark current measurements. The LCD panel will say: "Hardware Test…" and will list the software version number.

2. After the dark current measurements have finished, the LCD panel will display "RDY" followed by the instrument ID number, the location of measurements, the time, and the date.
3. If you are not going to use the Garmin GPS, the location, date and GMT time must be entered into the instrument. This is done as follows:
   3.1. Location:
      3.1.1. Press the [MENU/ENTER] key enter the menu mode. The LCD will display "-Main menu- -Clock-".
      3.1.2. Press the [Decr] button twice, until "Location" is chosen on the LCD. Press the [MENU/ENTER] key.
      3.1.3. The current location can be entered by either selecting a saved location or entering coordinates. Press the [MENU/ENTER] key to select options, and the [SCAN/ESCAPE] key to exit a menu level.
   3.2. Date and Time:
      3.2.1. Press the [MENU/ENTER] key enter the menu mode. The LCD will display "-Main menu- -Clock-".
      3.2.2. Press the [Decr] button five times, until "Clock" is chosen on the LCD. Press the [MENU/ENTER] key.
      3.2.3. Press the [MENU/ENTER] key again to select the "Adjust Clock" option.
      3.2.4. Enter the current GMT and date using the arrow keys. Press [SCAN/ESCAPE] when done.

4. Date, time and location are set automatically when using the Microtops II with the Garmin GPS connected. To ensure a proper connection, the communication baud rate must be set to 4800 bits/sec. This is done as follows:
   4.1. Press the [MENU/ENTER] key enter the menu mode. The LCD will display "-Main menu- -Clock-".
   4.2. Press the [Decr] button four times, until "Baud rate" is chosen on the LCD. Press the [MENU/ENTER] key.
   4.3. Use the arrow keys to select a baud rate of 4800. Press [Menu/Enter] to select, then [SCAN/ESCAPE] to exit the menu.
   4.4. The Microtops II can now be connected to the Garmin GPS. The Microtops II will beep when coordinates have been transferred from the GPS.

Figure 5: A Microtops II connected to a Garmin GPS 38

5. The Microtops II is now ready for use.

For more information, please refer to: "User's Guide: Microtops II Ozone Monitor & Sunphotometer."

Operation

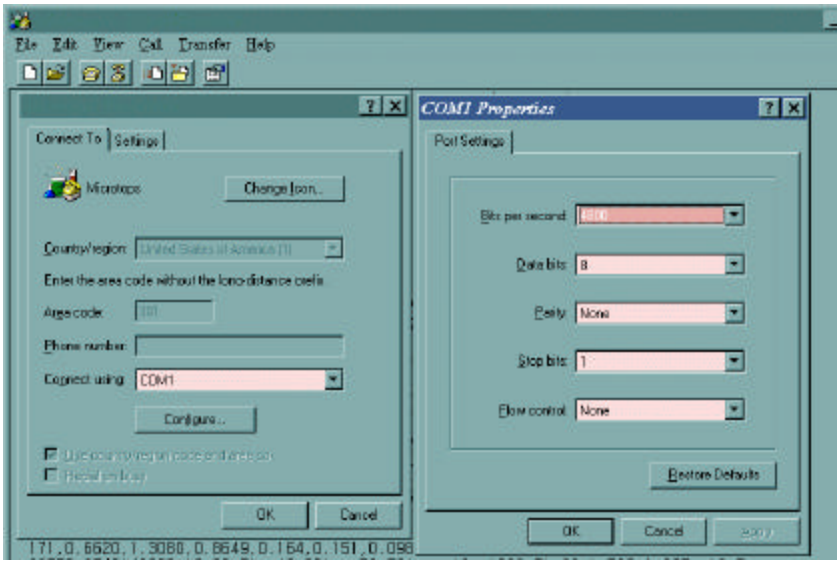
1. The Microtops II is intended for use in cloud free conditions. Before deployment, please be sure there are no thin cirrus (or any other type) clouds in front of the sun.
2. Open the optics cover completely.
3. Using the "Sun Target," aim the instrument at the sun. If needed, brace your arms to hold the instrument as steady as possible.

Figure 6: The Microtops II aimed at the sun

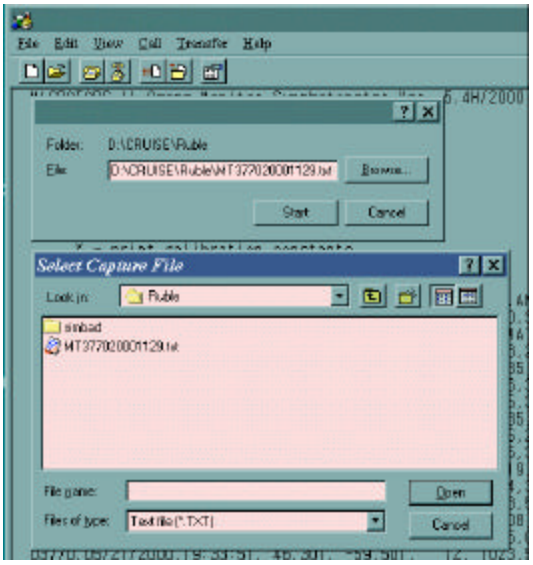
4. With the sun in the center of the “Sun Target,” press the [SCAN/ESCAPE] button to make a measurement. The current instrument protocol makes twenty measurements (in about six seconds) and saves the highest voltage value. This is intended to keep data best aimed at the sun.
5. Make fourteen more measurements immediately. This is essential so that a post processing algorithm can remove data not pointed properly at the sun.
6. Turn off the instrument using the [ON/OFF] button.
7. Be sure to turn the instrument off and on between each set of fifteen measurements. This helps account for temperature changes, as the dark current value is taken each time the Microtops II is turned on.
8. When the sun is low on the horizon, be sure to make more frequent measurements.

Downloading Data

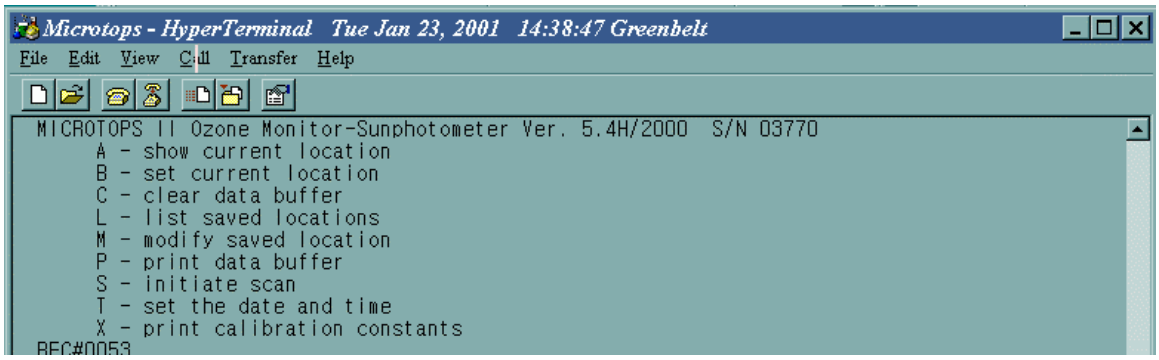
1. Using the serial cable provided with the Microtops II, connect the instrument to a PC.
2. Open the Hyperterminal software included with the PC.
3. Turn on the Microtops II.
4. Check that the Microtops baud rate (set to 4800 bits/sec for communication with the GPS) matches the baud rate set in Hyperterminal. This is typically found in the pull down menus [FILE], [PROPERTIES], then [CONFIGURE].



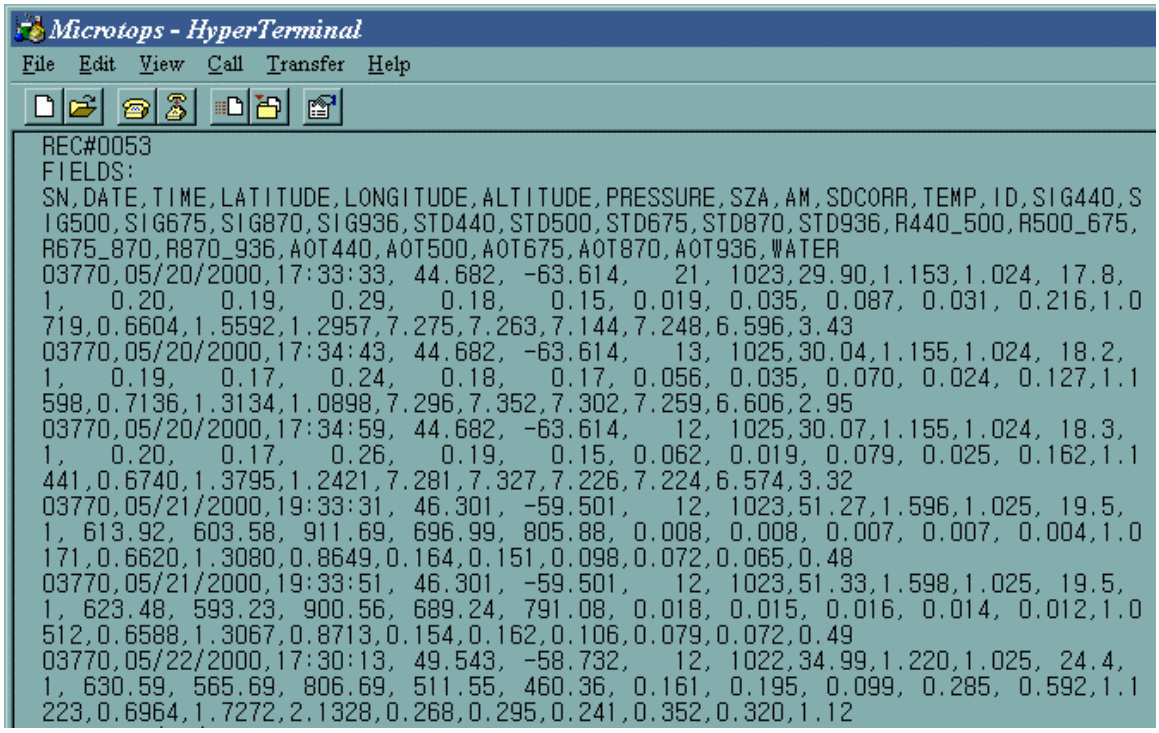
5. Open a file with Hyperterminal by using the menus [TRANSFER] and [CAPTURE TEXT]. The file naming protocol is MT[serial#][year][month][day].txt. For example, the filename MT377020011112.txt would be a file from instrument #3770, downloaded on November 12th, 2001.



6. Push the [RETURN] key to display the remote control keys with the Microtops II. These keys are:
   6.1. A – show current location;
   6.2. B – set current location;
   6.3. C – clear data buffer;
   6.4. L – list saved locations;
   6.5. M – modify saved location;
   6.6. P – print data buffer;
   6.7. S – initiate scan;
   6.8. T – set the date and time; and
   6.9. X – print calibration constants.



7. Press the [P] key to print the instrument data buffer.
8. Press the [X] key to print the current calibration constants.
9. Press the [C] key to clear the data buffer.



10. Close the file with Hyperterminal.
11. Submit the data to the SIMBIOS project at seabass.gsfc.nasa.gov.

For more information, please refer to: "User's Guide: Microtops II Ozone Monitor & Sunphotometer."

References

SIMBIOS Project: simbios.gsfc.nasa.gov/sunphotometers
SeaBASS Database: seabass.gsfc.nasa.gov
Solar Light Company: www.solar.com

Frouin, R., B. Holben, M. Miller, C. Pietras, J. Porter, and K. Voss, 2001: "Sun and sky radiance measurements and data analysis protocols," In Fargion, G., R. Barnes, and C. McClain, In Situ Aerosol Optical Thickness Collected by the SIMBIOS Program (1997-2000): Protocols, and Data QC and Analysis. NASA Tech. Memo. 2001-209982, NASA Goddard Space Flight Center, Greenbelt, Maryland, 26-42.

Knobelspiesse, K., C. Pietras, and G. Fargion, 2002: "Microtops II Handheld Sun Photometer Sun Pointing Error Correction for Sea Deployment," accepted for publication in J. Atmos. Ocean. Tech.

Pietras, C., M. Miller, R. Frouin, T. Eck, B. Holben, and J. Marketon, 2001: "Calibration of sun photometers and sky radiance sensors," In Fargion, G., R. Barnes, and C. McClain, In Situ Aerosol Optical Thickness Collected by the SIMBIOS Program (1997-2000):

Protocols, and Data QC and Analysis. NASA Tech. Memo. 2001-209982, NASA Goddard Space Flight Center, Greenbelt, Maryland, 11-21.

Porter, J.N., M. Miller, C. Pietras, and G. Motell, 2001: Ship-based sun photometer measurements using Microtops sun photometers, J. Atmos. Ocean. Tech., 18, 765-774.

SIMBAD HAND-HELD ABOVE WATER RADIOMETER AND SUN PHOTOMETER

Hardware

1) Charge the batteries of SIMBAD radiometer every night before doing any measurements. Use the AC adapter (110V or 220V) to charge the batteries.

2) Clean optics with non-abrasive paper or wipes and special cleaning solution. Do not put cleaning solution directly on the optics but use the wipes.

3) Turn on the SIMBAD as soon as possible and acquire a GPS record. It might take some time depending on your location. The next GPS acquisition will be faster.

Protocol

Based on the recommendations made by P.Y. Deschamps (LOA, Lille) and R. Frouin (Scripps, San Diego). See http://polaris.ucsd.edu/~simbad/ and http://loa.univ-lille1.fr/~simbad/

1) Turn on the SIMBAD the day before the experiment to get the closest location. It may take 30 minutes for the GPS to complete the search.

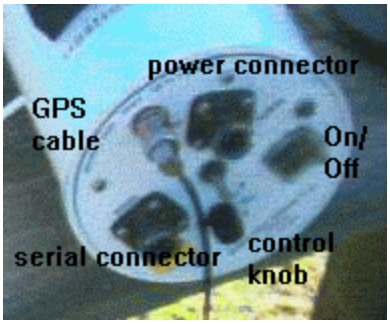
2) On the day of measurements, be sure to let the SIMBAD warm up for 1-2 hours prior to measurement. Between measurements, keep the instrument on and charging in the laboratory.

3) It is usually better to stand on the bow of the ship to do the sea reflectance measurements.

4) Secure the GPS by sticking it on the ship structure using the magnetic side. Choose a place that is not obstructed by any building. Connect the GPS. It is recommended to connect the GPS a long time in advance of the first measurement. The localization of the place could take more than 30 minutes on the first attempt. Once the localization has been done, the next attempts are faster.

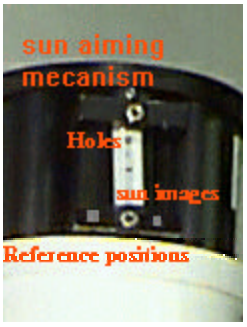
View of the control lights on the SIMBAD

5) Making sure the control knob is in the "PC" position, turn on the SIMBAD radiometer. Lights on the instrument will blink as the GPS identifies the location. Once this has happened, the lights will stop blinking and the instrument will beep. If this does not happen, change the location of the GPS and try again.



View of the back panel of the SIMBAD

6) First, make a dark measurement. Switch the control knob from "PC" to "dark". Place the lid at the end of collimator and place the radiometer in a black bag or inside a box. Press the red button to do one dark measurements. The two red lights will blink during 20 seconds and a beep is heard at the end of the operation.



Sun aiming mechanism of the SIMBAD

7) Now the instrument is ready to measure the sun. Switch the control knob from "dark" to "sun". Remove the lid and aim at the sun using the sun aiming mechanism. Get the image of the sun through the holes and align them on the reference positions. Press the red button to start the measurements. Measurements take 10 seconds each. The instrument will beep when completed. Repeat three times. Slight movements are acceptable since only the highest signal is kept.

8) Repeat one dark measurement. Switch the control knob from "sun" to "dark" and perform one more dark measurements. See 4).

9) Now the instrument is ready for sea measurements. Switch the control button from "dark" to "sea". Remove the lid, put the strap around your neck, go to the side of the ship. Aim at the ocean above the edge of the ship after having positioned the instrument at 135 degrees in azimuth from the vertical plane of the sun. Now tilt the

instrument down to the water. The two yellow lights will be on when the nadir viewing angle is 45 degrees. Press the red button to start the measurements. It takes 10 seconds and a beep is heard to indicate the end of the operation. Repeat three times.

10) Switch the control knob from "sea" to "dark" and perform one more dark measurements. See 4).

11) Switch the control knob from "dark" to "PC" before turning the SIMBAD off.

Recommendations

Please wait for the GPS signal to be found, even if it's sometimes a little bit long...

1) It is especially long to find the GPS signal when the SIMBADA was off for a long time or during shipping.
2) You may sometimes have to wait up to an hour... the best solution is to plug in the device using the main power supply and to try to find GPS as soon as you receive the device.

Do not hesitate to scan the tilt wildly between 30° and 60°, instead of trying to stabilize around 45°-50°.
Be advised to:

* Aim at the sun when recording SUN files.
* Aim at the sea when recording SEA files.
* Cover the optics when recording DARK files.
* Take written notes.

Downloading Data

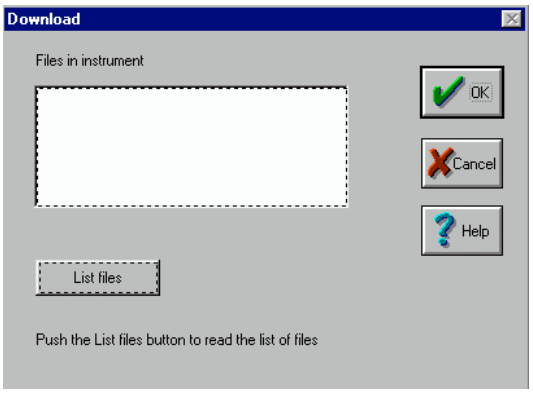
1) Connect the AC adapter to the SIMBAD before downloading measurements to avoid running low on batteries.

2) Use the serial cable provided with the SIMBAD and connect the instrument to the PC.

3) Use the SIMBAD software (on Windows 3.1, 95 or 98) to download the data.

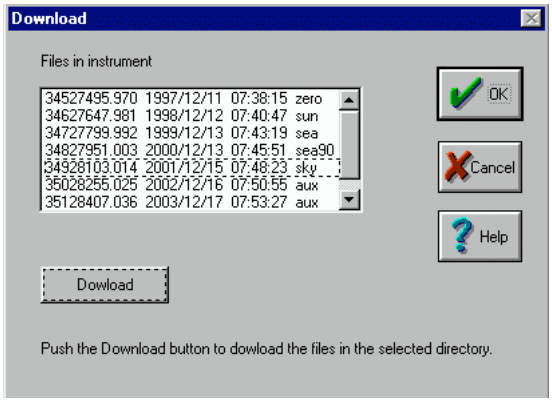
SIMBAD downloading software

4) Turn the SIMBAD on, put the control knob on "PC" position and press the red button to stop the automatic GPS initialization. Run the SIMBAD program. If the instrument is not connected or if the window does not appear, check the COM port using "Tools" to look in the simbad.ini file. Otherwise, push "Download".



Check list of files

5) Push "list files" to get the files stored in the memory.



Downloading files

6) Push "Download" to get the file in the PC computer.

7) Delete the data from the internal memory before turning the SIMBAD off.

SIMBADA ABOVE WATER RADIOMETER AND SUN PHOTOMETER

Hardware

1) Charge the batteries of SIMBADA radiometer every night before doing any measurements. Use the AC adapter (110V or 220V) to charge the batteries.

2) Clean optics with non-abrasive paper or wipes and special cleaning solution. Do not put cleaning solution directly on the optics but use the wipes.

3) Turn on the SIMBADA as soon as possible and acquire a GPS record. It might take some time depending on your location. The next GPS acquisition will be faster.

Protocols

Based on the recommendations made by P.Y. Deschamps and Guislain Becu (LOA, Lille) and R. Frouin (Scripps, San Diego). See http://www-loa.univ-lille1.fr/simbadA/simbad/public_html/index1.html

1) Turn on the SIMBADA the day before the experiment to acquire the first GPS record.

2) Recent studies at NIST have shown a 0.5 % instability during the first hour of SIMBADA operation. To avoid this problem, turn the SIMBADA on for at least one hour before use. Between measurements, keep the instrument on and charging in the laboratory.

3) It is usually better to stand on the bow of the ship to do the sea reflectance measurements.

4) Choose a place that is not obstructed by any building.

5) To turn on the device, use the switch located on the side panel and push the red button on the left side of the front panel.

6) The message "No GPS" is displayed on the bottom right, while the GPS antenna is initializing. The number of detected satellites is indicated in the top right of the display. When more than 3 satellites signals are found, the GPS antenna is initialized and the message "GPS. Ok" is displayed.

7) Press the red left button to select one of three scenarios/modes, namely DARK (measurement of dark current), SUN (sun viewing), or SEA (ocean viewing). The experimental procedure is to make, consecutively, one DARK measurement, three SUN measurements, three SEA measurements, three SUN measurements, and one DARK measurement.

-DARK mode: Press the red left button until display "BLACK" is displayed. Place cardboard at the end of collimator and/or dark cloth, so that no light can enter the instrument. Press the right green button to acquire the measurements. The display shows a

decreasing counter in the top right. The measurement lasts 10 seconds. A beep indicates the end of the measurement.

-SUN mode: Press the red left button once. (“SUN” is displayed). Aim at the sun (the sun image must be seen through the reticle) and press the right green button to acquire the measurements. The measurement lasts 10 seconds. A beep indicates the end of the measurement. The sun azimuth angle is stored in memory.

-SEA mode: Press the red left button once more. (“SEA” is displayed). Go to the side of the ship, aim at the ocean when the instrument is positioned 135° from the sun vertical plane and 45° down from the nadir. Use the relative azimuth angle from the sun vertical plane displayed on the top middle of the display to find the best position, try to keep the SIMBADA horizontal and press the right green button to acquire the measurements. The measurement lasts 10 seconds. A beep indicates the end of the measurement.

Note: To avoid viewing the ship trail or foamy sea, it is better to scan continuously the sea between 30° and 60°. !!!Be sure that the tilt IS NOT greater than about 20°, so that the polarizer remains in a suitable position!!!

Operate the SIMBADA during daytime when the sun disk is not obscured by clouds, outside foam, and whitecaps. Ideally, weather permitting, the measurements should be made:

1) at each station during daytime (if the ship stops offshore)

2) while the ship is moving around local noon (time of SeaWiFS overpass). The best ship location to make the measurements is the bow. Because the SimbadA might be affected by sea water, "en route" measurements should be made only when there is no risk of wetting the instrument. If seawater gets into the instrument, clean the exterior optics.

The following meteorological data should be acquired concurrently, whenever possible: date, time, Lat., Lon., cloud cover and type, air temperature, dew point (or wet bulb), temperature, surface pressure, visibility, wind speed, wind direction, whitecaps (none, low, moderate, or high), water temperature, surface chlorophyll, phaeophytin, etc.... Some of these data may be available from the bridge log.

Recommendations

Please wait for the GPS signal to be found, even if it's sometimes a little bit long...

1) It is especially long to find the GPS signal when the SIMBADA was off for a long time or during shipping.
2) You may sometimes have to wait up to an hour... the best solution is to plug in the device using the main power supply and to try to find GPS as soon as you receive the device.

Do not hesitate to scan the tilt wildly between 30° and 60°, instead of trying to stabilize around 45°-50°.
Be advised to:

* Aim at the sun when recording SUN files.
* Aim at the sea when recording SEA files.
* Cover the optics when recording DARK files.
* Take written notes.

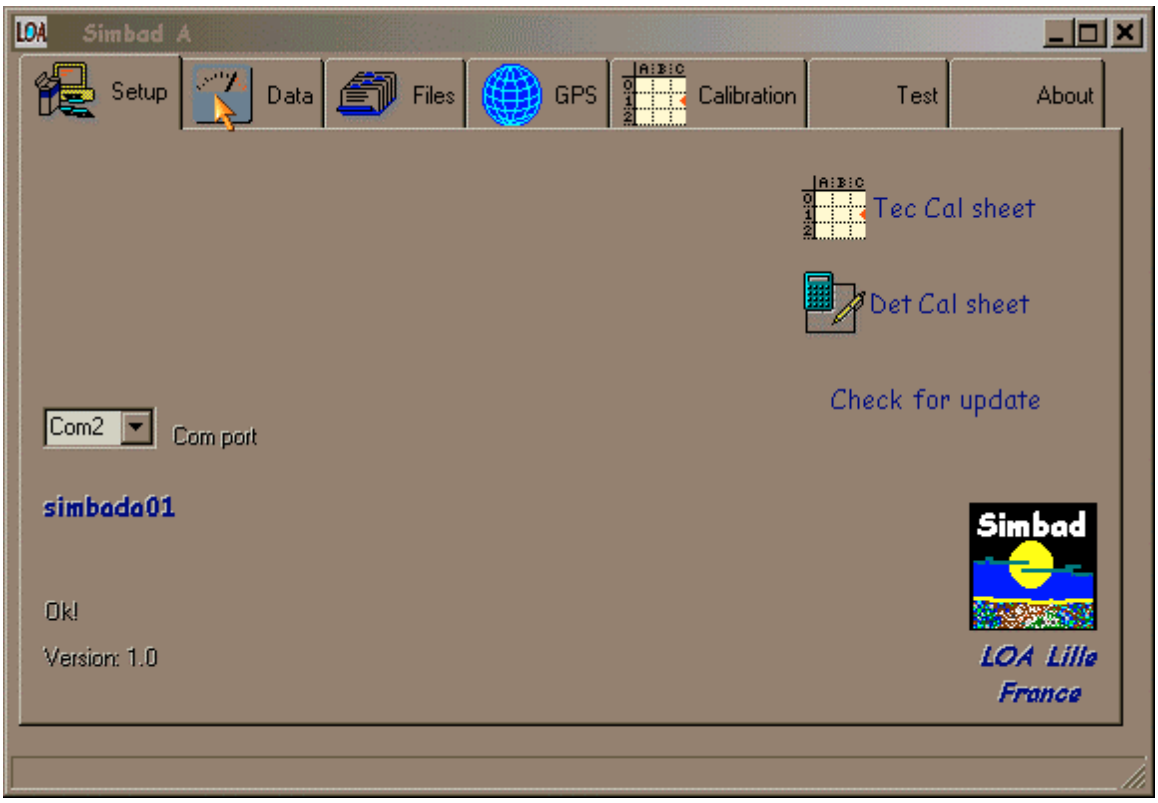
Be also careful when recording a SEA file to keep the SIMBADA horizontal for the polarizer to cut properly the reflected sky radiation.
When recording a set of records, start with a SUN record (after a dark file of course), and note on the LCD display the cap. Then, when recording a SEA file, try to have a relative azimuth angle of 135° between SUN and SEA records (the cap on the is displayed in degrees).

If you notice problems with bad data, or erroneous screen display, the SIMBADA can be reset if you do an entire data erase from the downloading software.

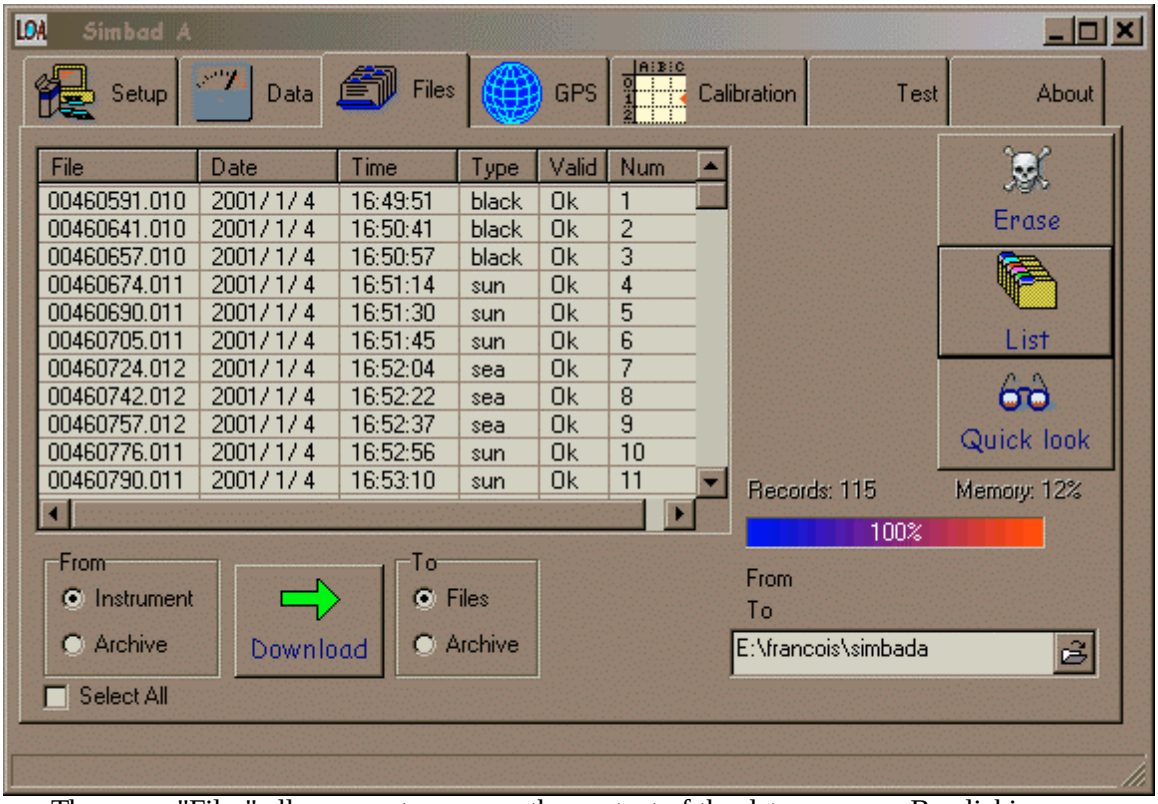
Downloading Data

Connect the PC cable to the instrument. Turn the instrument on. Run the SIMBADA executable program, and follow instructions on the menu as explained below. Save the data on a floppy disk or on the hard drive. Delete the data from the internal memory. Turn off the instrument.
The interface provided has been widely tested and works on Windows 95, Windows 98® and Windows NT® operating system. Below, we successively and succinctly describe the various menus. To turn on the device on, you have to use the switch located on the side panel and push the red left button on the front panel.

If you install the interface for the first time, you need to decompress the archive file Simprog.zip (winzip format), and install it in a dedicated folder, for example "C:\simbada\".
NOTE: From the version 1.2.2.2 of the interface, you do not need to install again this archive, the procedure is explained below. Nevertheless, to upgrade this version of the interface (version 1.2.2.0) to the version 1.2.2.2, you need to download the winzip archive Simupdt.zip, place it in the same folder, and execute the file Simist.exe.



You can choose the serial port Com1 or Com2 on which the SimbadA device is connected. For example, if the device is present and connected to the PC, the message "simbada01 connected" is displayed in the bottom left corner, elsewhere "no connection" or "Please wait!!! " are displayed. In that latter case, either the instrument is not switched on, or the device is not connected on the specified serial port.



The menu "Files" allows you to manage the content of the data memory. By clicking on the "List" button on the right hand side, you can list the files stored in the memory and the percentage of memory used. Each file corresponds to one line on the grid. Each file contains several pieces of information: Name of the file, date of record, time of record, type of file (Dark, Sun, Sea, ExtraSun, ExtraSea,....), validity flag, and recording number.

- You can edit the content of one file using the "Quick look" button.
- You can select either one file or a selection of files by selecting them with the mouse and the Shift key.
- You can also save all the files in memory by clicking on the "Select all" button in the lower left corner.
- You have the choice to save the data on disk in the folder specified in the box on the lower right corner, either in a "file by file" format by choosing "From: Instrument To: Files " or in an archive file. This archive could be read again by choosing "From: Archive To: Files", and then the files could be save on disk the same way as above.
- you can empty the memory by clicking on the "Erase" button. A dialog box will then appear to confirm or not your intention. You can then verify that the memory is empty by clicking again on the "Files" button.

PREDE MKII AUTOMATIC SUN PHOTOMETER

Based on the PREDE POM 01 Mark II documentation.

Hardware

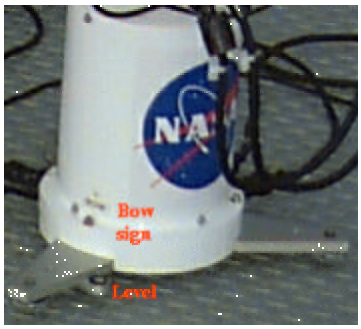
1) Check the desiccant pellets located in housings of the wide field of view camera, the narrow field of view camera and the sensor head. Pellets colored blue still have their absorption properties, while pink pellets are wet and will not efficiently absorb condensation. Replace pink pellets or place them in the microwave for 30 seconds. Do not overheat.

2) Clean optics with non-abrasive paper or wipes and the special cleaning solution. Do not put cleaning solution directly on the optics but use the wipes.

Optics of the PREDE MKII shipborne version

Installation

1) Install the PREDE on a stable platform. Align the BOW sign on the radiometer to the bow of the ship, or the North if measurements are taken on land. Check the level located on one leg of the radiometer robot. Adjust the level if necessary.



View of BOW sign and the level mechanism on the Robot

2) Connect the cables. Protect the PREDE control box from the rain and sun. Install the GPS on a flat surface free of obstruction for one best quality of communication. Connect the serial cable to the laptop. The serial cable is powered using the DC charger provided.

PREDE control box and serial cable connected to the PC

3) Connect the other cables and tape the outdoor connectors using the tape roll provided.

4) Turn the PREDE radiometer and the laptop computer on.

Protocol

1) Run DOS mode on the labtop computer (by pushing the "F8" key, windows is not run).

2) Copy OBS.DAT and CCDAURA.EXE into a directory named PREDEMK2. Create a directory named C:\PREDEMK2\DATA.

3) In the OBS.DAT file put the correct latitude and longitude of the current site. Check the PATH where the data will be stored. It should be C:\PREDEMK2\DATA Check the angles for the sky measurement procedure (use the standard angles recommended in the PREDE documentation).

4) Check the date and time of the laptop. Local or GMT time can be used, however, I prefer using GMT.

5) Type "set tz=GMT0" if you use GMT time or "set tz=EST+X" if you use Eastern Time, X is the time difference with GMT time. See PREDE documentation page 20 for further details.

6) Type "ccdaura" to run the software. The robot will look for the "zero" of the azimuth and zenithal motors then go to park mode. Check parameters are displayed on the monitor screen. Check tha date, time and location displayed. Control the quality of GPS transmission (DOP field). A value between A and D means acceptable quality. The closest to A minimize error. Q means no communication. Change the position of the GPS to get the best result.

Park mode

7) Push “T” key and mask the sun sensor and the narrow field of view camera. The PREDE should find the approximate location of the sun. Unmask the sensors. The PREDE should correct its position. Refine the position and leveling of the PREDE radiometer if necessary. Repeat the procedure again and adjust the position. Push the key “T” to go back to the park position.

Sun tracking mode

8) If something goes wrong, refer to PREDE documentation for further tests: page 21, point 5.5.

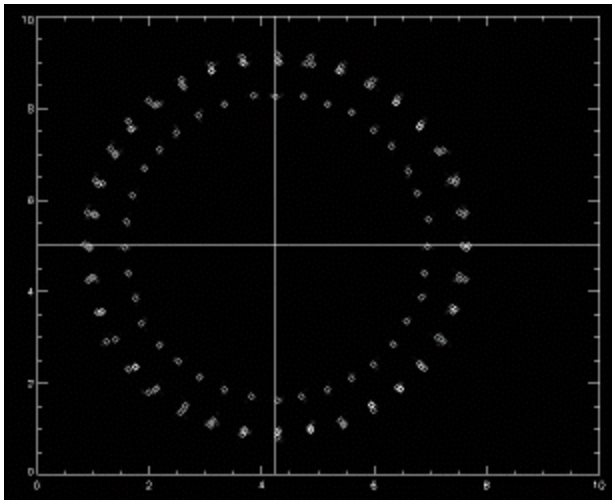
9) Push the keys “0” to “7” to select one of the wavelengths

10) Push the “S” key to synchronize the PC time to that obtained by the GPS unit.

11) Push the “K” key to check the light axis. The PREDE will measure the radiance in the area of +/- 1-degree from the present sun tracking position and the angle at the center of gravity will be displayed.

12) Push the "O" key to make immediate measurements that follow the protocol angles in OBS.dat file.

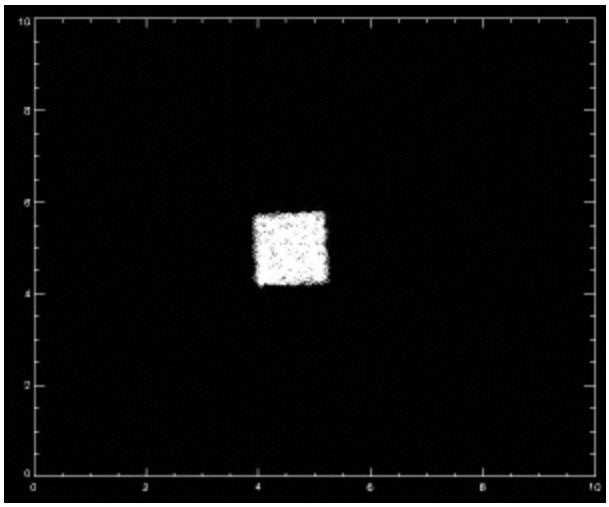
13) Push the "F" key to make wide FOV camera measurements. The sensor tube is at horizontal position and the tracker rotates for 360 degrees in 10 degrees step.



Wide FOV camera images

14) Push the "G" key to make continuous wide FOV camera measurements. End by pushing the "ESC" key.

15) Push the "N" key to make narrow FOV camera measurements. Enter the angle (A) for each step (degree), enter the max step (B). Max angle=A*B will be displayed. See page 11 of the manual for further details. Measurements are made in the four directions (+/- B) from the present sun tracking position in the steps of A degree. Protocol is performed while correcting for the movement of the sun.



16) Push the "W" key to make continuous narrow FOV camera measurements. End by pushing "ESC" key.

17) Push the "D" key to measure the radiance with the presently used wavelength in the +/- 1 degree's area to four directions from the present sun tracking positions in the steps of 0.1 degree. Push "A" key to do the same at all wavelengths.

18) Push the "ESC" key to quit.

19) After one day of measurements, rename the files as follows:

- OBS.DAT ? yyyymmdd.obs. Necessary only if you plan to change obs.dat for other observations.

- Narrow.dat ? yyyymmdd.NRW

- Fish.dat ? yyyymmdd.FSH